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ABSTRACT

It is common to think of toxic wastes as chemical poisons like lead, mercury, or radioactive waste. Poisonous as these substances may be, there is another class of toxic wastes that are far more poisonous. These are the wastes produced by living bacteria and viruses. This booklet considers three aspects of toxic wastes: time, space, and spirit. Time refers to a sense of history; space refers to geography; and spirit refers to life and thought. Several chapters on the history and concepts of biological and non-biological toxins, a time line related to the concepts, a map of the important geography related to these concepts, a glossary of important terms, and a list of several study suggestions are included. (CW)

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Toxic Wastes

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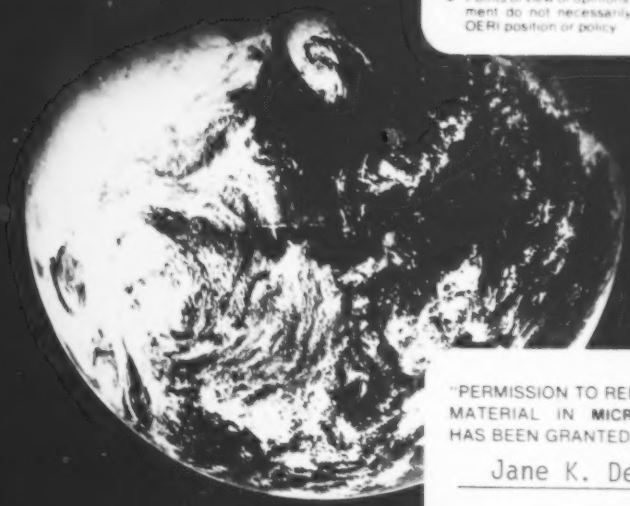

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A HAWKHILL LEARNING POWER BOOK

TIME, SPACE AND SPIRIT

KEYS TO SCIENTIFIC LITERACY

To the student,

This short book will help you understand our modern world. It has changed a lot since your parents were born. Even more since you were born. And it will change still more–much more–in your lifetime.

What is behind most of these big changes? Two things. Science and technology.

What can you do about it? The first step is to understand more about science and technology and how they connect with our world. Especially the ever-growing world of free democratic societies. One way to do this–the way this book follows–is to look at the world from three angles: *Time, Space* and *Spirit*.

Time means history. You can learn how science and technology have worked in the past and are working today.

Space means geography. You can learn where important things happened in the past and are happening today.

Spirit means life. The life of the mind. You can learn the key words, concepts and ideas that power science and technology (and society) today.

This book teaches about science, technology and society from all three of these angles–*Time, Space* and *Spirit*.

Read on.

This book belongs to:

Toxic Wastes

Bill Stonebarger
Illustrations by Lin Haley

Hawkhill Associates
Madison, Wisconsin

This book is one of a series of sixteen Learning Power Books in the *Time, Space and Spirit–Keys to Scientific Literacy* series. It is designed to accompany the video program of the same name.

The *Time, Space and Spirit–Keys to Scientific Literacy* series was written and produced with consultation from the History of Science Department at the University of Wisconsin-Madison.

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Part 1: A History of Toxic Wastes

epidemics

In 1854 over five hundred people died from the poison carried by a well at Golden Square, near the center of London, England. All of the victims lived within a few blocks of the well. The well was only a few feet from a sewer pipe. A London physician, John Snow, figured out the connection between the sewer pipes, the well and the disease. Once he convinced the authorities to remove the pump handle, forcing people to get their drinking water elsewhere, the cholera epidemic in that neighborhood ended.

how to stop them

It was one of the first times in human history that an epidemic had ended because someone figured out how to stop it.

To better understand our problems with toxic wastes today, let's first look at history. What were

toxic waste problems like in the past? When and how did people learn to understand and to control them?

lead poisoning

Start our survey with the Roman Empire, some two thousand years ago. Among other assorted ills, epidemics and wars, there was chronic lead poisoning in many cities of that time and place.

The lead came from cooking utensils, especially wine-making vats. Some historians think the long-range effect of the lead poisoning, which affects the brain particularly, was one of the major causes of the fall of the Roman Empire around the year A.D. 400.

toxic wastes from living things

Today we tend to think of "toxic wastes" as chemical poisons like lead, mercury, arsenic, PCBs, plutonium and other radioactive wastes. Poisonous though these chemicals may be, there is another class of toxic wastes that, ounce for ounce, are far more poisonous. These are the wastes produced by living bacteria and viruses. These are the poisons that maim and kill under names like cholera, rabies, yellow fever, smallpox, polio, botulism, measles, malaria and AIDS.

the Black Death

Between 542 and 594, one-third of the people in Europe died of this kind of toxic waste! That is one out of every three people on a whole continent! This toxic waste was made by a bacteria that was carried from rats to fleas to people. In every case the poison from this bacteria, once it got into the human body, had the same devastating effect. The stricken person would go pale and start shivering. Scarlet blotches and black boils would quickly appear. Fever would rise rapidly, the patient would become delirious, and in a few hours would be dead. It was called the Black Death.

The same Black Death and other equally widespread epidemics of other germ-caused diseases made many people think the world was going to end in the year 1000. The world didn't end. But in the middle of the fourteenth century, once again over a third of the people of Europe died in another outbreak of the Black Death!

syphilis epidemic

In the fifteenth century a terrible syphilis epidemic spread throughout Europe, killing, blinding and maiming millions of people.

in New York, a million people die?

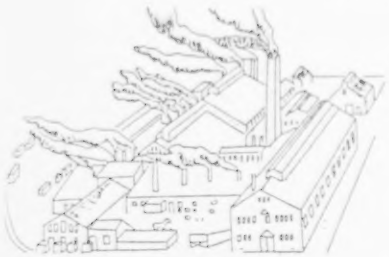
To get a better idea of just how catastrophic these poisons have been in the past, consider some numbers. When Newton retreated to his country home to discover the laws of motion in 1665, he left behind the Great Plague of London–a plague that killed 68,000 people in three months! That is 68,000 people out of a total population of 400,000. If a similar catastrophe were to strike New York, Los Angeles or Chicago today, the death toll in one summer would be over a million people in each city!

death tolls worse in Asia

So far I have mentioned examples in Europe only. Move into Asia or South America or Africa and the death tolls get worse. Terrible though the wars of history have been, the terror, misery, suffering and death brought by toxic wastes have always been even more catastrophic.

the "good old days"

Lest you think this was only the long long ago and the far far away, the "good old days" of the nineteenth century in this country and Europe were not much better. We know today that the smoke from factory stacks, or the foul liquids from factory sewers are threats to our health. In the nineteenth century, however, there were few cities that did not publish advertising posters proudly exaggerating the black smoke belching from their booming factories. They considered the smoke a sure sign of progress!



dirty streets

What they didn't show was the appalling amount of raw sewage, garbage and filth that littered the streets. They didn't show the children competing with the pigs for food in the garbage heaps.

windowless rooms

They didn't show the thousands of poor people who lived in tiny windowless rooms with such a lack of air circulation that over three thousand died in one heat wave in New York in 1896.

frontier towns

Smaller frontier towns in the west were no better. In places like Helena, Montana, for instance, the hitching posts for horses quickly turned into filthy cesspools.

Pittsburgh

The advertising posters didn't show the chemical poisons mixed up in all that factory smoke the cities were so proud of. A Hungarian visitor to Pittsburgh in those days described the industrial

smoke as "a noisome vomit, killing everything that grows–trees, grass, and flowers."

rickets

The disease called rickets was especially common in all the industrial cities and towns of Europe. The rickets was caused by the blocking of sunlight in the cities and villages by factory smoke. In the early nineteenth century this is how one visitor described a small industrial town in Germany, where the sky was darkened continually by the dense factory smoke.

"The children must sit indoors, which ends in death or if they continue to live, they develop thick joints, cease to be able to walk, or have deformed legs. The head becomes large and even the vertebral column bends. It comes to pass that such children sit often for many years without being able to move; at times they cease to grow and are merely a burden to those about them."

food and water contaminated

Food and water supplies were especially vulnerable and tainted with many toxic chemicals and disease-causing germs. Unscrupulous vendors and manufacturers were even known to deliberately add toxic substances to bread, candy, milk and to the first canned goods–in order to make them look better, go further or last longer. Even when honest, food markets exposed raw meat and fish for days on end to the dust and dirt of the streets, making for dangerous dinners.

drugs and alcoholism

And then there was the poisoning from drugs. Alcoholism was extremely common. Jacob Riis counted 111 Protestant churches below 14th St. in New York versus 4065 saloons. In Chicago near Jane Addams' Hull House there were nine churches and 250 saloons.

heroin as cough medicine

Morphine, heroin and opium addiction were common. Infants were fed Winslow's Baby Syrup or Kopp's Baby Friend, both of which were liberally spiked with morphine. Heroin was marketed as a cough medicine in 1898. The result of all this toxic binge was what you might expect. Epidemics, poisonings, malnutrition and drug addiction. The "good old days" in other words, were only good in relation to the worse old days of medieval or ancient times.

progress in past

Was there no progress then? And are our problems today minor ones?

Of course there was progress in the past. And no, our toxic problems today are far from minor. The point of this fast trip through history is not to dismiss or to minimize the problems of today, but rather to put them into perspective. And more important, to take heart from and learn from the success stories of the past.

two kinds of toxic wastes

To understand the success stories remember there are two kinds of toxic wastes. (1) The toxic wastes generated by disease-causing organisms like cholera, black death, botulism, syphilis, etc. as well as those produced by toxic plants, molds and fungi, and (2) the toxic wastes generated by human activities, like the chemicals in factory smoke, landfills and sewage systems.

a country doctor makes a breakthrough

The first big success in the fight against nature-produced toxic wastes came from the work of a country doctor in England around the time of the American Revolution. Ed-

ward Jenner learned how to use one toxic waste to destroy another toxic waste!

Jenner conquers smallpox

Jenner learned to prevent a serious disease, smallpox, by vaccinating people with the germs of a much milder disease, cowpox. The immediate practical result–an astonishing victory over one of humankind's most dreadful scourges–was important enough. But Jenner's work provided, in addition, the model for the future elimination of a hundred other germ-caused diseases.

vaccination, a model

The vaccination model said–inoculate the person with a small amount of a toxic substance, or the microorganism able to produce the toxic substance. This inoculation will stimulate the human body itself to produce antitoxins. Antitoxins are chemicals that will fight and neutralize the poisons. In this way the body will develop immunity to future doses of the same or similar toxic substances.

using the model

Using that model, scientists to follow, giants like Louis Pasteur, Robert Koch, Ignaz Semmelweis, Walter Reed, Alexander Fleming and Jonas Salk gave us the knowledge and the technology needed to conquer rabies, typhoid, diphtheria, whooping cough, childbed fever, polio and a thousand other infectious diseases.

chemical industry successes

Essential to that winning battle was the chemical industry. With increasing knowledge of atoms and molecules, chemists began to custom make chemicals that could produce miracles.

Ehrlich's "magic bullet"

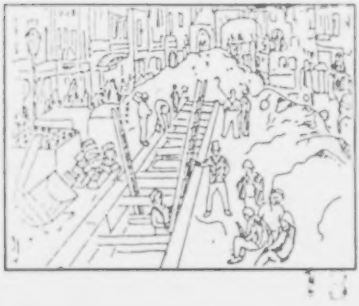
Paul Ehrlich in Germany discovered a specific chemical, a "magic bullet" it was called, that could cure the dreaded syphilis. His arsenic bullet was the beginning shot in modern chemotherapy. Since then researchers have found many more "health bullets." Chemicals that can purify water, kill germs and hasten sewage treatments. Chemicals that can preserve food, cure ailments, prevent tooth decay and counteract toxic chemicals.

environmental pioneers

Chemical drugs, new vaccines and hard working researchers could not do the job alone, however. Equally important in the fight for a healthy environment were thousands of not so well known engineers, politicians, early environmentalists and concerned citizens. They were the pioneers who, alone and together, all over the country and all over the world, gradually put together the pieces of community health programs.

sanitarians

These early nineteenth century pioneers were called sanitarians. They were the pioneers who created the world's first sanitation systems, garbage collection systems, safe water supplies, laws to restrict animals in the city, laws to control food and drug production and sale, pollution controls on factory and home and, most important of all–education for community and individual health.



epidemics in sharp decline

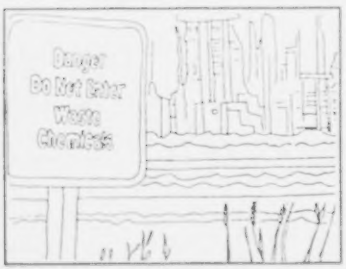
These new public health laws and systems have worked remarkably well in changing human history. Today, in the industrialized world, disease epidemics are rare. When they do come they can usually be stopped with minimal suffering and loss of human life. This does not mean, of course, there is no cause for concern today. The recent AIDS epidemic is a sobering example that science is not all-powerful.

clean water the rule

Safe water supplies are now the rule, rather than the exception. The gross pollution of the nineteenth and early twentieth century, in other words, has been brought under control–in the industrialized world of North America, Europe and Japan, that is. In many of the poorer countries of Asia, Africa and South America, on the other hand, many of these same battles for sanitation are still being fought. And slowly won.

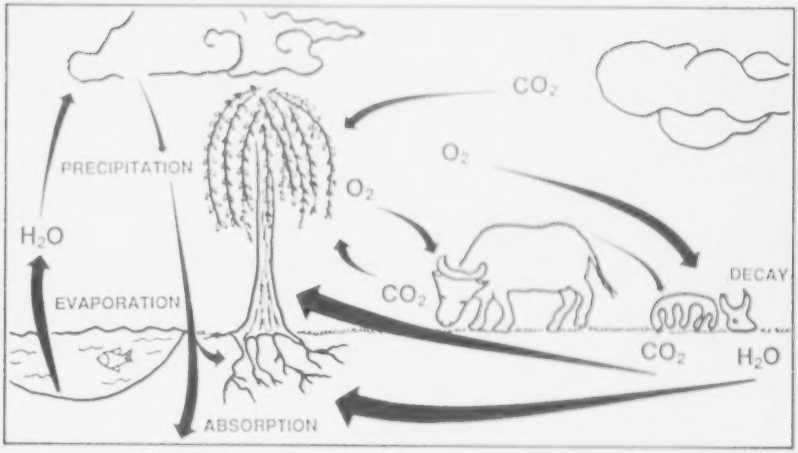
new worries about toxic wastes today

Does that mean that the toxic waste challenges are disappearing from our world? Far from it. They have changed. Where once we had to worry about an entire city being wiped out by bubonic plague, or disfigured by smallpox, or poisoned by foul water, today we have to worry about the subtle long-range effects of chemicals we never heard of before. Chemicals that in many cases never existed before. Chemicals like plutonium and PCBs and dioxin. Or chemicals that were there but we never knew they were there, nor had any way of detecting them–like asbestos and minute amounts of metal ions and slow buildup of acids in the air.



problems and opportunities

Heartened by the courage and eventual success of our ancestors, let's turn to our modern toxic waste problems and opportunities in the second part of this program.



PBB in Michigan

Just about everyone who lives in Michigan carries around with him or her small amounts of a toxic chemical called PBB–polybrominated biphenol. Just about everyone who lives in the United States carries around with him or her small amounts of radioactive iodine.

toxic lead

And just about everyone who lives in the world carries in his or her living tissues small amounts of toxic lead.

food chains

In each of these cases the toxic chemicals got there by the same route–through the food chains and chemical cycles of the biosphere.

fear of the unknown

In each of these cases the chemicals are potentially dangerous to human health And in each of these cases, and the hundreds like them that regularly hit the evening news, fear of the unknown can sometimes turn out to be more harmful than the toxic chemical itself.

Let's look at what we do know, and at what we don't know about toxic wastes in our living world today.

what is a toxic waste?

First we need to get clear on what toxic waste is. How poisonous, in other words, does it have to be to be labelled a toxic waste?

EPA standards

The U.S. Environmental Protection Agency, the EPA, has set standards that reflect the best medical judgement today about this question. There is nothing sacred or certain about these figures, remember. They are educated guesses, derived mostly from animal studies.

testing for toxicity

A sample batch of mice or rats or monkeys is given very large doses of a suspected chemical. The doses are usually in the form of food, but they can be breathed in with the air, or applied to the skin.

If health problems result, further tests are made and then scientists make some estimate of the likelihood that humans might be harmed (even though they get much smaller doses). What is the statistical likelihood, for instance, of developing cancer from PBB? Or birth defects from dioxin? Or lung problems from asbestos?

studies on humans

When possible, studies of humans who have accidentally been subjected to the chemical in past work situations or accidents are also made. Or, in the case of cigarette smoking, of humans who have and do deliberately subject themselves to suspect chemicals.

problems with studies

There are serious scientific problems with all of these studies. For one, suspected chemicals are usually present in extremely small amounts. Of-

ten the concentrations are expressed in parts per billion.

parts per billion

To give you an idea how small an amount that is, if you were trying to find the one part per billion of lead in the glass of water you are drinking, it would be like looking for one second in thirty-four years. Or like walking around Lake Michigan to find one lost penny. And yet, amazingly enough, scientists today can actually locate one part per billion, even one part per trillion or quadrillion in a sample of living tissue, or a handful of soil, or a flask of air!

new chemical techniques

To do it they use extremely sensitive new chemical techniques like electrophoresis and chromatography. With these new tools, chemists can identify and measure toxic substances that once were totally undetectable. Chemists can be more and more precise about what and how much of any suspected toxic substance is present in the air, earth, water, food or human tissue.

biologists uncertain

Biologists, unfortunately, cannot be equally precise about the health hazards these infinitesimally small amounts bring with them. In a few cases the evidence is strong and clear. Cigarette smoking, for instance, exposes the lungs to a wide variety of toxic substances that almost certainly lead to a much higher risk of developing lung cancer, emphysema, and other respiratory diseases, as well as heart disease.

Industrial chemicals

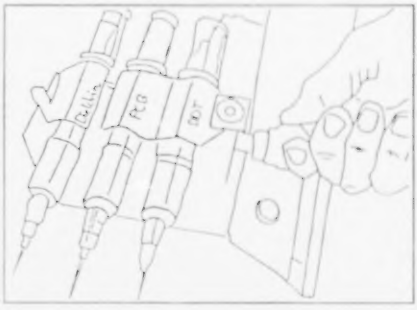
Asbestos fibers, coal dust and other industrial and mining chemicals, when inhaled or ingested over a long period of time are known to cause cancer and other severe lung and intestinal problems.

lead harmful

And too high a concentration of lead is known to cause mental retardation and other serious nervous system problems.

Love Canal and other crises

Other toxic substances that have received much publicity in recent years are known to cause problems in experimental animals under relatively high dosages, but as yet have not been shown to cause any human damage. In some of the most highly publicized cases–Love Canal, Three Mile Island, PBB contamination in Michigan, and dioxin contamination in Times Beach, Missouri–later studies have so far failed to show any health effects to human populations in the vicinity.



long-term effects

Of course, we cannot be certain in these or any other cases that longer-term maladies will not occur. Cancer, for instance, as well as most genetic diseases, takes a long time to develop.

nature is not benign

It should be noted that threatening though the toxic wastes from industry may be, nature is not benign either. In fact, ounce for ounce, gram for gram, nature's toxic wastes are even more potent than the ones we have generated in our factories.

concentration is all important

In both cases, though, the concentration of the toxic chemical is all-important. While we should try to err on the safe side, we should not panic at every newspaper account of a toxic waste scare.

deadly natural chemicals

We are surrounded by natural toxic chemicals, and have been for centuries. In the nineteenth century, for instance, babies often died from drinking milk from cows who had eaten the common but deadly weed, rattlesnake root. Many chemicals made by natural organisms, like the bacterium Clostridium botulinum (source of the deadly botulism) are far more potent than any of the new synthetic chemicals.

carcinogens in natural foods

Recent careful scientific work has found that many, indeed most, of our ordinary foods–things like celery, figs, mushrooms, coffee, tea, potatoes, peanuts, rhubarb, herbs, mustard, eggs, butter, lettuce, spinach, cheese, fruit and all kinds of meat and fish–contain significant amounts of carcinogens and mutagens–that is, cancer-causing and mutation-causing chemicals!

carcinogens and mutagens

This has no connection with whether fertilizers, insecticides or pesticides were used in their production. These carcinogens and mutagens are natural to the plants and were made by them long before there were any human beings to eat them.

plants protect themselves with toxic chemicals

Plants, in other words–probably all plants–produce an enormous number of potentially toxic chemicals designed to protect them against other plants, against insects, against organisms who want to eat them. A recent article in the journal *Science* pointed out that the average person each day takes in at least 10,000 times as much of nature's pesticides as he or she does of manmade pesticides.

stop eating?

What can we do then, stop eating?

good news from nature

Fortunately there is good news from nature as well. Despite the relatively high amounts of carcinogens and mutagens in natural foods, these concentrations are still small enough to apparently not cause much, if any, damage. And more good news–plants also seem to produce many other chemicals that combat cancer, detoxify poisons, and that prevent mutations. Plants also produce chemicals that help destroy harmful parasites in our bodies.

knowledge incomplete

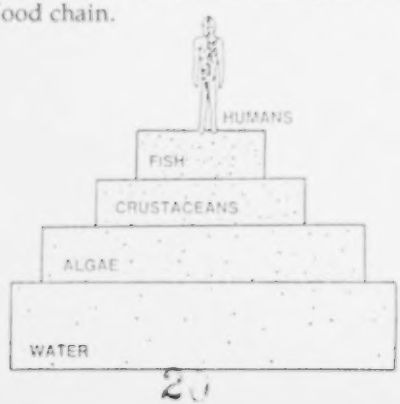
Unfortunately, at the present time our knowledge of these natural chemicals–as of the manmade synthetic ones–is very incomplete. It is enough, though, to give us perspective, caution and hope.

food chains and chemical cycles

Besides caution in trying to assess the degree of toxicity, we must also remember that any toxic substance is only toxic if it actually enters the living body. In other words, in order to hurt us we have to eat it, drink it, breathe it in or take it in through our skin. To keep it out, we need a better knowledge of food chains and chemical cycles in the biosphere.

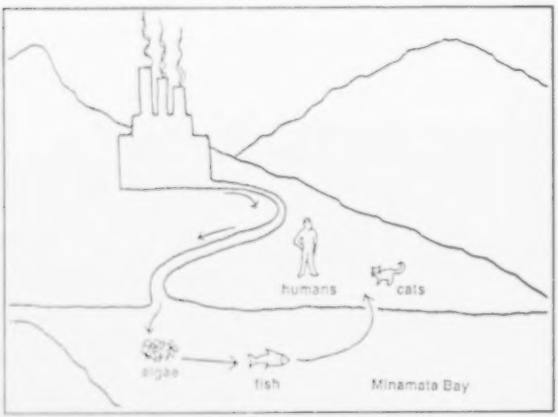
concentration in a food chain

Here is a diagram of a food chain that illustrates how a toxic chemical can become ever more concentrated as it passes through the chain. Concentrated enough to cause serious harm to humans and to all other living creatures in the food chain.



tragedy in Japan

A seaside factory had for many years been sending its wastes, which contained substantial amounts of mercury compounds, into Minimata Bay in Japan. There these wastes were taken up by the algae. Which in turn were eaten by small crustaceans. Which in turn were eaten by fish. Which in turn were eaten by humans.



toxic mercury is selectively concentrated

At each step up the food chain the mercury compounds were selectively concentrated by the living organisms, until by the time they were taken in by the humans, the mercury compounds were concentrated enough to cause serious problems. Nervous systems were affected by the mercury. Pregnant women were especially vulnerable and gave birth to deformed children.

tragedy in Michigan

Here is another example. A diagram of a food chain in Michigan. Again a mistake. An animal feed worker accidentally put a bag of a fire retardent, Firemaster, into some animal feed. The Firemaster contained the toxic chemical PBB, polybrominated biphenol, known to cause cancer in animals.

a serious mistake

Before the mistake was discovered, thousands of cows throughout southwestern Michigan had eaten the feed and concentrated the PBB in their milk. Pigs, chickens and sheep were also affected. And so too were humans throughout southwestern Michigan who ate the milk, pigs, chickens and sheep. Fortunately in this case the amounts were small enough that as yet no human health problems have shown up.

huge economic losses

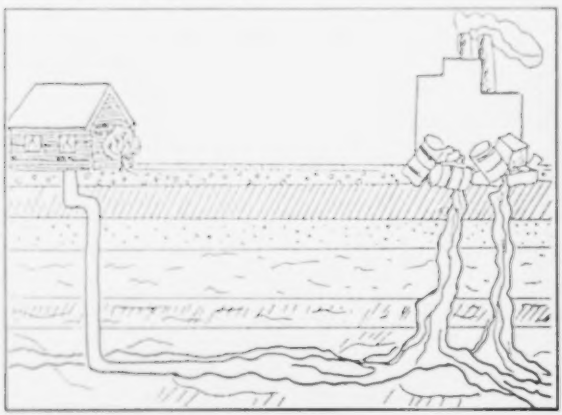
In order to protect humans however, the Michigan mistake did result in huge economic losses. Over 23,000 cattle, one and a half million chickens and thousands of pigs, sheep and other animals had to be sacrified. Losses to farmers, insurance companies and taxpayers were enormous.

landfills

One of the most serious sources of future toxic pollution may come from old and new landfills. Dumps, as they used to be called.

potential "time-bombs"

We know that over past decades industrial companies, as well as municipalities and individuals have regularly used landfill sites to dispose of wastes. The EPA has now identified over 15,000 of these waste disposal sites as being potentially hazardous, 419 as especially hazardous, and twenty as high priority "time-bombs."



leaking drums

One worry is that leaking drums in mass burial sites will leak toxic chemicals into the water table. This means they will get into wells, rivers, lakes and the ocean. Which means they may be taken up and further concentrated by living creatures, and who can predict what and how much harm will result?

what can be done?

What can be and is being done to prevent possible harm to the biosphere?

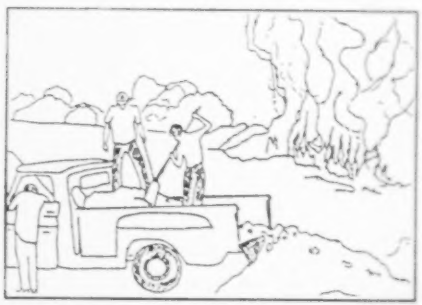
No two waste sites are exactly alike. Many have an alphabet soup mixture of chemicals, some relatively harmless, some very toxic. Other problems are confined to a single toxic waste. Some sites are on relatively impervious clay. Others are near the water table, or rivers, or lakes.

need more knowledge of chemicals

Some chemicals are very soluble in water, others are not. Some chemicals tightly bond to the soil particles, others do not. Some are easily taken up by plants or animals, others are not. Some are harmful on contact with the skin, others are not. And some we have little data on–we don't know what they do in living systems, or how or whether they enter the food chains or chemical cycles of nature.

solutions vary

As the problems are different, the solutions vary. Some solutions can be as simple as moving drums from a poorly situated site to a well-situated one. Sometimes incineration is the best choice. Sometimes a solution can involve covering the waste site with clay first, then putting soil on top.

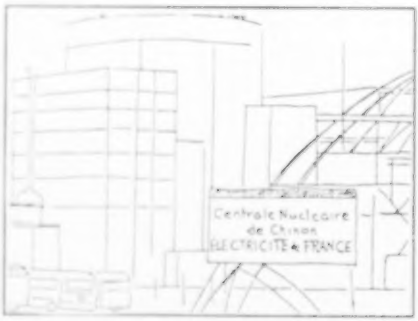


methods at Love Canal

Sometimes we need to, in addition, build walls around the dump, even pass any drainage from the site through activated charcoal. This is the method being used at the Love Canal site near Niagara Falls, and thus far the effluent coming out of the old dump site is clean, and the quantities of chemicals collected on the charcoal are very small. No health effects have shown up.

radioactive wastes

With high-level radioactive wastes, the solutions are more difficult. The major problem here is the long time spans involved. Wastes from nuclear plants and from the production of nuclear explosives will remain dangerously radioactive for hundreds, even thousands of years. How can they be isolated from the living biosphere for such long periods of time?



is problem insoluble?

Some nuclear critics say they can't–the problem is insoluble. Others, the majority, say solutions here are neither impossible nor exhorbitantly expensive. One feasible way they suggest is embedding the wastes in impervious ceramic, and then burying these in deep mines.

natural toxic wastes

Many scientists think the most difficult toxic problems, as well as the least understood and recognized, are the natural toxic wastes that come from plants we eat. Next to cigarette smoking, our dietary practices probably contribute more to cancer and other diseases than any other single environmental factor. We have only begun the scientific job of evaluating the natural chemicals in all food. But we have begun.

new knowledge needed

As in the nineteenth century, it will take many skills and much new knowledge to protect our environment and our health in future years. For ourselves and for our children, and for our children's children.

new skills needed in social arenas

For this task we need not only biologists, chemists and doctors–just as important we need new knowledge in engineering, new skills in the educational, political and social arenas, and new understanding and support from citizens.

three fronts of progress

To do an effective job, it will take a concerted attack on at least three fronts.

(1) We need to find ways to not generate so many toxic wastes.

(2) We need to find ways to safely dispose of those we must and do create.

(3) We need to find new and creative ways to use our wastes for the good of ourselves and of the biosphere. To recycle them, in other words.

natural resources of tomorrow

And who knows, in another decade or a hundred years from now, what we now look on as toxic waste sites may well turn out to be valuable natural resources for the technologies of tomorrow. That is the way it was with excrement from bats in caves of the past. That is the way it was with coal, oil, and gas. And that is the way it is already happening (to a still limited extent) with many of our wastes of today.

sewage sludge from Chicago

One example. Much of the sewage sludge from the city of Chicago is now being barged to sites in north-central Illinois, where strip mining has ruined the land. This sewage sludge is pumped from the barges and sprayed on the impoverished soil. Here it serves as a rich fertilizer. Already

thousands of acres of formerly abandoned land has been restored to agricultural productivity.

bacteria and paper mills

Another example. Biologists have found bacteria that can convert the waste from paper mills in Wisconsin into useful chemicals rather than harmful pollution in our rivers and lakes. In new and exciting research they are working now to find ways of helping these bacteria use their power more efficiently and ecomonically.

help in cleaning up oil spills

New strains of bacteria have also been found to help clean up oil spills. They are being used to help clean the beaches in Alaska after a tanker spilled huge amounts of oil into the harbor at Valdez.

bad news and good news

While you are keeping a lookout for the latest toxic waste scare stories in your local newspaper, keep an eye out for the good news as well. For other stories like the ones above. They are happening all the time, and can be expected to continue and accelerate in years to come.

TIME ...

To understand the world of today it helps to know something about the world of yesterday. Kings and queens, wars and famines, presidents and paupers have all played a part. But more important than any of these in changing the past world into the world of today has been science and technology. The time line below will help you place important events and people in historical time.

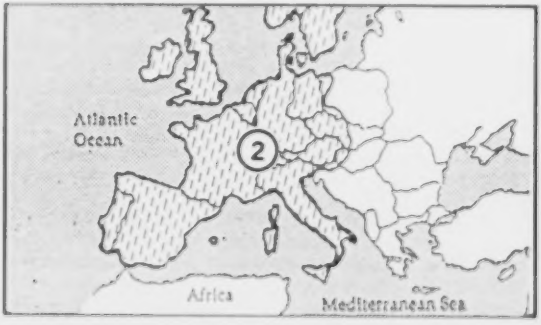
EVENTS IN WORLD HISTORY		EVENTS IN SCIENCE & TECHNOLOGY
500 B.C. to A.D. 400 Roman Empire		
	1000	A.D. 1000 Epidemics lead people to think the world will end
500-1300 Medieval Europe	1100	
	1200	
	1300	14th Century One-third of Europe dies in Black Death
	1400	
1400 to 1600 Renaissance	1500	
	1600	1665 Great Plague of London
	1700	
1775-1777 American Revolution	1800	late 18th century Jenner vaccinates for smallpox
1861-1865 American Civil War	1900	mid-19th century Pasteur, Koch and others conquer infectious diseases
1939-1945 World War II		late 20th century PCB, dioxin, radioactivity, acid rain and more

SPACE ...

There is a saying, "If you don't know where you are going, any road will get you there." One of the important parts of knowing where you are going is a knowledge of geography. The maps below will help you to locate the important events and people discussed in this book.

1. Roman Empire

The center of the civilized world for over nine hundred years. Historians disagree as to why the Roman Empire eventually declined and fell apart in the fifth century A.D. Some say chronic lead poisoning contributed to this fall. (Light boundary lines are of modern European states.)



2. Medieval Europe

During the Middle Ages there was progress in technology, science, agriculture and the beginnings of trade. There were also terrible setbacks when epidemics repeatedly killed up to one-third of all Europeans. (Light boundary lines are of modern European states.)

1. Chicago, Illinois — Sewage sludge from Chicago is being barged to north-central Illinois where it is used to rehabilitate strip mined land, bringing it back to agricultural productivity.

2. Lake Michigan — Finding "one part per billion" would be like walking around the entire lake to find a penny.

3. Love Canal — Near Niagara Falls, New York. An old landfill site that leaked toxic chemicals into people's backyards.

4. Times Beach, Missouri — Site of dioxin contamination in the 1980s.

5. Three Mile Island, Pennsylvania — Site of accident at a nuclear power plant where radioactive particles escaped into the environment in 1982.

* Asterisks mark spots where the EPA says there are serious toxic waste problems from old landfills. Some call them "time-bombs."

SPIRIT...

Time and space are meaningless without spirit. Spirit is the part in each of us that understands. The part that sees connections between words and things–connections that surprise and make sense. Study the key words, concepts and ideas below so that you can understand how time, space and spirit have worked in the past–and are working today.

AIDS — A serious, usually fatal, virus-caused disease for which there is at present no vaccine and no cure. (p. 9)

antitoxins — Chemicals made by a living organism to neutralize poisons. (p. 7)

arsenic — One of the chemical elements. Certain of its compounds are highly toxic. (p. 2)

asbestos — A rock fiber known to cause lung cancer and other diseases when taken into the body in repeated exposures. (p. 9, 11, 13)

bacteria — A microscopic living thing of only one cell. Most bacteria are harmless, some are helpful, and a few are harmful. (p. 2, 14)

biologists — People who study living organisms. (p. 12)

biosphere — The very thin outermost layer of planet Earth where life flourishes. (p. 10, 15)

Black Death — A deadly epidemic that ravaged Europe many times during Medieval times, sometimes killing as many as one-third of all the people in a town or country. (p. 2-3)

botulism — A deadly disease caused by a bacteria that thrives in some decaying foods. (p. 6, 14)

carcinogen — A substance known to cause cancer. (p. 13-15)

chemical cycles — In the biosphere all chemicals change and cycle into and out of air, earth and water. Some cycle into and out of living things. (p. 10, 15-16)

EPA — Short for Environmental Protection Agency, a branch of the Federal government with the job of protecting our environment. (p. 11)

epidemic — A rapid multiplication of some disease in a certain area, large or small. (p. 1-3, 8-9)

food chains — A way of tracing the path of foods as one creature eats another which has eaten another, etc. etc. (p. 10, 15-16)

genetics — The science of heredity, how traits are passed on from parents to offspring. (p. 13)

mutagen — A substance that is known to cause mutations in living cells. (p. 14)

parts per billion — A way of measuring how much of any chemical is present, how many "parts" of the chemical per "billion" parts of the environment. (p. 12)

Louis Pasteur — A great French chemist in the 19th century who is generally credited with leading the way in the understanding and control of many infectious diseases in plants and animals, including human beings. (p. 7)

PCB — Polychlorinated biphenol. A class of chemicals often used industrially that do not readily break down in the natural environment and are suspected of causing cancer in human beings. (p. 9)

plutonium — A fissionable element used in nuclear reactors and bombs. Highly toxic to living organisms. (p. 9)

pollution — When and where our air, water or soil is contaminated by unwanted substances. A matter of degree. Pollution can be more or less toxic. (p. 1, 4-6, 8-9, 17-21)

radioactive wastes — Leftovers from military, industrial or research projects that are potentially harmful because of their short- or long-life radioactive energy. (p. 19)

smallpox — A serious disfiguring and often fatal disease, now easily prevented by vaccination. Because of

the success of smallpox vaccination, the virus responsible for the disease is now extinct on earth. (p. 2, 6-7)

syphilis A serious disease transmitted through sexual contact. (p. 3, 8)

toxic waste Any unwanted substance that is poisonous to living organisms. A matter of degree. Toxic wastes can be more or less poisonous.

vaccine A substance injected into a plant or animal that protects it from getting some disease. (p. 7)

In addition to the above, *Toxic Wastes* also teaches about other important people, places, things and ideas. Often you can figure out the meaning of a new word by seeing how it is used in context. Make sure you know the meaning of the following. For help, check the pages listed in this Learning Power Book, as well as your dictionary and encyclopedia:

acid rain (p. 9); **Adams, Jane** (p. 5); **dioxin** (p. 9, 11, 13); **Ehrlich, Paul** (p. 8); **emphysema** (p. 12); **Jenner, Edward** (p. 7); **landfills** (p. 17-19); **London, England** (p. 1); **lung cancer** (p.12); **mercury** (p. 16); **natural resources** (p. 20); **Newton, Isaac** (p. 3); **pesticide** (p. 14); **Pittsburgh, Pennsylvania** (p. 4); **rickets** (p. 5); **Riis, Jacob** (p. 5); **Roman Empire** (p. 2).

STUDY SUGGESTIONS ...

1. The stories of Pasteur, Koch, Semmelweis, Snow, Ehrlich and other health pioneers of the 19th century are scientifically fascinating and full of human interest. The famous American writer and cynic, H. L. Mencken, called the story of how we learned to effectively fight back against the toxins created by disease germs, "the noblest chapter in human history." Read the dramatic details of this story in some of the books in the bibliography, especially the classic, Paul de Kruif's *Microbe Hunters*.

2. The history of the Black Death has been studied for clues as to what happens in a society when extreme calamity strikes. Compare the statistics over the centuries from various epidemics, wars and toxic catastrophes. Remember to take into account population totals in making comparisons to catastrophes today.

3. Make a study of your home town's efforts to control toxic wastes. When did community garbage and trash collections begin? Who and what were the forces that brought them into being? How about community water supplies? Sewage treatment plants? Laws and regulations regarding animals in the city? Are there problems today?

4. The chemical industry has been accused by many critics in recent years of irresponsibility about toxic waste problems. By library research and by writing to environmental watch-dog groups and to the chemical companies themselves investigate both sides of this issue–the good done by new chemicals vs. the toxic dangers posed by new chemicals.

5. Some readers and viewers may be surprised to learn that ordinary natural foods may have relatively high levels of carcinogens and mutagens. Much of this data comes from articles by Dr. Bruce Ames, head of the biochemistry department at the University of California-Berkeley. Read his articles (see bibliography) and discuss with class.

6. Hardly a week goes by that some new toxic chemical does not make the news. Analyze the newspaper reports of some crises. How does the toxicity of the suspected chemical compare with the toxicity of known natural sources like peanut butter, celery and herbal teas? (See Ames' article for figures on these and other natural sources.) Analyze the rhetoric used in the newspaper report–how much is scare, how much is fact?

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Wohl, Anthony S. *Endangered Lives: Public Health in Victorian England*. Cambridge, MA: Harvard University Press, 1983.

The following organizations can be helpful in providing information on current toxic waste issues:

American Council on Science and Health, 1995 Broadway, New York, NY, 10023. 212-362-7044. This organization has many short inexpensive pamphlets on subjects related to toxic wastes and health. Sample titles: "America's Health: A Century of Progress But a Time of Despair," "Antibiotics in Animal Feed: A Threat to Human Health?," "Pesticides in Your Home and Garden," "Dioxin in the Environment," "PCBs: Is the Cure Worth the Cost?," "Diet and Cancer," "Does Nature Know Best? Natural Carcinogens in American Food," "Answers about AIDS."

Chemical Manufacturers Association, 2501 M St. NW, Washington, DC 20037. 202-887-1100.

Citizen's Clearinghouse for Hazardous Wastes, P.O. Box 926, Arlington, VA 22216. 703-276-7070.

EPA (Environmental Protection Agency), 401 M St. SW, Washington, DC 20460. Pesticide and Toxic Substances Program Hotline, phone toll-free 800-424-9346. The EPA also has regional offices. Check your local phone book.

National Agricultural Chemicals Association, 1155 15th St. NW, Washington, DC 20005. 202-296-1585..

National Audubon Society, 950 Third Ave., New York, NY 10022. 212-832-3200.

Renewable Resources Foundation, 5430 Grosvenor Lane, Bethesda, MD 20814. 301-493-9101.

Resources for the Future, 1616 P St. NW, Washington, DC 20036. 202-328-5025.

Sierra Club, 730 Polk St., San Francisco, CA 94109. 415-776-2211.

U.S. Council for Energy Awareness, Suite 400, 1776 Eye St. NW, Washington, DC 20006-2495. 202-293-0770.

Waste Watch, P.O. Box 39185, Washington, DC 20016. 202-895-2601.

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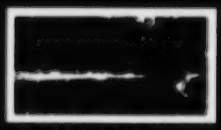

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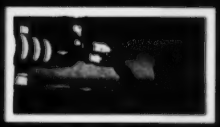

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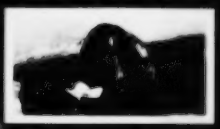

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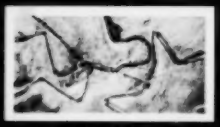

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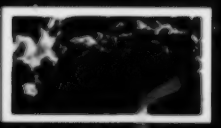

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